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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: JAMES BROC STIRTON	Examiner: Juan D. Valentin
Serial No.: 09/824,156	Group Art Unit: 2877
Filed: April 2, 2001	Att'y Docket: 2000.071000/TT4354
For: METHOD OF MEASURING IMPLANT PROFILES USING SCATTEROMETRIC TECHNIQUES	Customer No.: 23720

APPEAL BRIEF

MAIL STOP AF
Commissioner of Patents
P.O. Box 1450
Alexandria, VA 22313-1450

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Sir:

Applicants hereby submit an original and two copies of this Appeal Brief to the Board of Patent Appeals and Interferences in response to the Final Office Action dated September 23, 2004.

The Director is authorized to deduct the fee for filing this Appeal Brief ($340) from Advanced Micro Devices, Inc. Deposit Account No. 01-0365/TT4354. In the event the monies in that account are insufficient, the Director is authorized to withdraw funds from Williams, Morgan & Amerson, P.C. Deposit Account No. 50-0786/2000.071000.

I. REAL PARTY IN INTEREST

The present application is owned by Advanced Micro Devices, Inc.

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II. RELATED APPEALS AND INTERFERENCES

Applicants are not aware of any related appeals and/or interferences that might affect the outcome of this proceeding.

III. STATUS OF THE CLAIMS

Claims 1, 2 and 4-37 are pending in the application. Claim 3 has been canceled. Claims 1, 2 and 4-37 stand rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over Kleinknecht (U.S. Patent No. 4,1833,123) in view of Kotani (U.S. Patent No. 5,105,362). The claims currently under rejection, *i.e.*, claims 1, 2 and 4-37, are attached as Appendix A.

IV. STATUS OF AMENDMENTS

The amendments to the claims proposed in Applicants' Response to Office Action Dated April 27, 2004 have been entered.

V. SUMMARY OF THE INVENTION

In general, the present invention is directed to several inventive methods relevant to the measurement of various characteristics of implant regions formed in a semiconducting substrate. In one illustrative embodiment, the method comprises illuminating a first plurality of implant regions with a light source in a scatterometry tool, and generating a trace profile corresponding to an implant profile of the illuminated implant regions. In another embodiment, the method comprises illuminating a plurality of implant regions, measuring light reflected off the substrate to generate a profile trace for the implant regions, comparing the generated profile trace to a target profile trace, and modifying, based upon a deviation between the generated profile trace

and the target profile trace, at least one parameter of an ion implant process used to form implant regions on subsequently processed substrates.

VI. <u>ISSUE ON APPEAL</u>

1. Whether claims 1, 2 and 4-37 are unpatentable as being obvious (35 U.S.C. § 103) in view of Kleinknecht and Kotani.

VII. <u>GROUPING OF THE CLAIMS</u>

It is believed that there are two distinct claim groups. Claims 1, 2 and 4-7 define a first group and claims 8-37 define a second group. It is believed that the distinction between these various groupings is warranted for a variety of reasons. For example, the first group (claims 1, 2 and 4-7) is generally directed to a method involving forming a plurality of implant regions in a substrate, illuminating the implant regions with a scatterometry tool to generate a trace profile that corresponds to an implant profile of the illuminated implant regions and creating a library comprised of a plurality of calculated trace profiles of implant regions having varying implant profiles. In short, independent claim 1 is directed to a unique methodology involving illuminating a plurality of implant regions to generate trace profiles corresponding to the implant profile of the implant regions and creating a library comprised of a plurality of <u>calculated</u> trace profiles of implant regions having varying profiles.

In contrast, independent claim 8 is directed to a control methodology involving measuring the light reflected off a plurality of implant regions formed in a substrate to generate a profile trace for the implant regions, comparing the generated profile trace to a target profile trace and, <u>if a deviation exists</u> between the generated profile trace and the target trace, <u>modifying at least one parameter of an ion implant process used to form implant regions on subsequently</u>

processed substrates. That is, independent claim 8 is directed to a methodology involving forming additional implant regions on subsequently processed substrates based upon a deviation detected between a generated profile trace and a target profile trace. The methodology set forth in independent claim 8 is not suggested or obvious from the invention set forth in claim 1. In the invention defined in claim 1, there is no suggestion to take the additional steps set forth in claim 8 that involve modifying parameters of subsequent ion implantation processes based upon a deviation between the generated profile trace and the target trace.

Similar arguments apply to the other independent claims (*e.g.*, 16, 24 and 31). However, some of those claims undertake to modify a parameter of an ion implantation process based upon a deviation between the generated profile trace and a calculated profile trace (as opposed to a target trace). Accordingly, it is believed that the claims defined by these separate groupings are patentably distinct from one another and thus stand or fall separately.

VIII. ARGUMENT

A. Claims 1, 2 and 4-37 Are Allowable Over Kleinknecht and Kotani

As the Board well knows, to establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 U.S.P.Q.2d 1438 (Fed. Cir. 1991); M.P.E.P.

§ 2142. Moreover, all the claim limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d 981, 180 U.S.P.Q. 580 (CCPA 1974). If an independent claim is nonobvious under 35 U.S.C. § 103, then any claim depending therefrom is nonobvious. *In re Fine*, 837 F.2d 1071, 5 U.S.P.Q.2d 1596 (Fed. Cir. 1988); M.P.E.P. § 2143.03.

With respect to alleged obviousness, there must be something in the prior art as a whole to suggest the desirability, and thus the obviousness, of making the combination. *Panduit Corp. v. Dennison Mfg. Co.*, 810 F.2d 1561 (Fed. Cir. 1986). In fact, the absence of a suggestion to combine is dispositive in an obviousness determination. *Gambro Lundia AB v. Baxter Healthcare Corp.*, 110 F.3d 1573 (Fed. Cir. 1997). The mere fact that the prior art can be combined or modified does not make the resultant combination obvious unless the prior art also suggests the desirability of the combination. *In re Mills*, 916 F.2d 680, 16 U.S.P.Q.2d 1430 (Fed. Cir. 1990); M.P.E.P. § 2143.01. The consistent criterion for determining obviousness is whether the prior art would have suggested to one of ordinary skill in the art that the process should be carried out and would have a reasonable likelihood of success, viewed in the light of the prior art. Both the suggestion and the expectation of success must be founded in the prior art, not in the Applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 U.S.P.Q.2d 1438 (Fed. Cir. 1991; *In re O'Farrell*, 853 F.2d 894 (Fed. Cir. 1988); M.P.E.P. § 2142.

Applying these legal standards, it is respectfully submitted that the Examiner erred in rejecting the pending claims. Independent claim 1 includes the step of creating a library comprised of a plurality of calculated trace profiles of implant regions having varying implant profiles. As set forth in the specification at page 10, calculated profile traces associated with a particular implant profile or characteristic may be calculated using Maxwell's equations and rigorous coupled wave analysis (RCWA) for a variety of, if not all, possible combinations of

implant profiles readily anticipated by the design process. As thus understood, it is respectfully submitted that neither Kleinknecht nor Kotani, nor any other art of record, disclose the entirety of the steps set forth in independent claim 1. More specifically, none of the art of record discloses the step of <u>creating a library</u> comprised of a plurality of <u>calculated trace profiles of implant regions having varying implant profiles</u>.

As understood by the undersigned, Kotani is directed to a system for managing production of semiconductor devices. Col. 1, ll. 11-15. Kotani discloses that a typical production line is comprised of a plurality of production apparatus 11a and a plurality of inspection apparatus 11b. The production apparatus 11a perform various processes on successive semiconductor wafers, while the inspection apparatus 11b inspect partially finished products which have been prepared by the production apparatus. Col. 1, ll. 19-33. Kotani further notes that in a conventional production line, the production apparatus and the inspection apparatus are allowed to operate independently regardless of errors and malfunctions in the production apparatus and the inspection apparatus. Col. 1, ll. 61-66.

To alleviate such problems, Kotani discloses a system comprised of a central processing unit 12 which performs real-time, on-line control of the production apparatus and the inspection apparatus. Col. 3, ll. 18-20. The processing managing system disclosed in Kotani is comprised of three blocks. The first block 10 is a processing managing area which manages the various processes performed by the production apparatus and the various inspections performed by the inspection apparatus. Col. 3, ll. 40-44. The second block 20 is a data accumulation area which is connected to the process managing means 10. The data accumulation means 20 accumulates and stores various data which have been acquired over a long time such as the results of processes or inspections conducted in the production line, data obtained through various tests

conducted by an external evaluation system and the like. Col. 3, l. 57 – Col. 4, l. 5. The data accumulation means 20 provides for reference to the accumulated data as well as for statistical computation using such data. The third block 20 of the system disclosed in Kotani is a simulation area. The simulation means 30 simulates the operation or characteristics of the semiconductor devices produced by the semiconductor production line on the basis of the data stored in the data accumulation means 20. Col. 4, ll. 12-16. The simulation means 30 further determines optimum conditions for <u>subsequent processes</u> to be performed and delivers the data for those optimum conditions to the process managing means 10. Col. 4, ll. 16-19. The simulation means 30 can perform process simulations, device simulations and circuit simulations. Col. 4, ll. 19-31.

At no point does Kotani disclose at least the step of providing a library comprised of a plurality of <u>calculated trace profiles</u> for <u>implant regions having varying implant profiles</u>. Such a limitation is simply not disclosed in Kotani. In fact, it is hard to understand how any of the disclosure of Kotani could be construed as a disclosure of this limitation. Thus, the Examiner's obviousness rejection of claim 1 based upon the combination of Kleinknecht and Kotani was improper as the combination of such art lacks at least this limitation. Moreover, there is simply no suggestion in Kleinknecht or Kotani to modify these teachings so as to arrive at the invention defined by independent claim 1. In view of the foregoing, it is respectfully submitted that the Examiner erred in rejecting independent claim 1. Applicant respectfully requests that the Board <u>reverse</u> the Examiner's rejection of claim 1 and all claims dependent therefrom.

It is also respectfully submitted that the Examiner erred in rejecting independent claim 8. Claim 8 requires, among other things, forming a plurality of implant regions in a semiconducting substrate, illuminating and measuring light reflected off the substrate to <u>generate a profile trace</u>

for the implant regions, comparing the generated profile trace to a target profile trace, and modifying, based upon a deviation between the generated profile trace and the target profile trace, at least one parameter of an ion implant process used to form implant regions on subsequently processed substrates. In rejecting claim 8, the Examiner asserted that Kotani shows the steps of comparing the generated profile trace to a target profile trace and modifying based upon a deviation between the generated profile trace and the target trace at least one parameter of an ion implant process used to form implant regions on subsequently processed substrates (citing col. 1, ll. 22-25, col. 3, l. 57 – col. 4, l. 5 and col. 5, ll. 14-32). Final Office Action at pp. 5-6. Applicant respectfully disagrees.

Kotani is understood to be a system and method for predicting the effectiveness of processes and treatments that are yet to be performed on substrates to manufacture semiconductor devices:

> "Then, the simulation CPU 31 simulates the subsequent production processes for semiconductor devices by employing the actual data of the processes which have already been performed and the process flows for the following processes which are yet to be performed. In consequence, it is possible to predict, before all the remaining processes and treatments are completed, the operation and characteristics of the semiconductor devices which are to be obtained when all processes and treatments are carried out according to the program. The result of the simulation is accumulated in the data base 32 and is displayed as desired on the CRT 33.
>
> "In the event that the characteristics of the simulator semiconductor device are not acceptable, the conditions of the processes and treatments which are to be subsequently carried out are varied in accordance with the statistical data computed by the data accumulation means 20, and the simulation is executed once again with varied conditions, whereby the conditions of the processes which are to be subsequently performed are optimized for the production of the semiconductor devices having the desired operational characteristics."

Col. 5, ll. 20-42 (emphasis added). As thus understood, it is respectfully submitted that the methodology defined by independent claim 8 is not obvious in view of Kleinknecht or Kotani, or

any other art of record. More specifically, Kotani is directed to a forward looking methodology that involves potentially modifying downstream process recipes based on an analysis of data obtained regarding substrates that were previously subjected to other process operations. In effect, the methodology disclosed in Kotani attempts to predict future results for a planned processing scheme and modify that processing scheme (or parameters thereof) if the predicted results are unacceptable.

In stark contrast, independent claim 8 is directed to a process whereby implant regions are illuminated and measured and the generated profile trace is compared to a target profile trace. Thereafter, independent claim 8 requires modifying, based upon a deviation between the generated profile trace and the target profile trace, at least one parameter of an ion implant process used to form implant regions on subsequently processed substrates. In short, claim 8 involves a feedback type of control wherein at least one parameter of an ion implant process used to form implant regions on subsequently processed substrates is modified if there is a deviation between the generated profile trace and the target profile trace. At no point does Kotani disclose the steps of generating and comparing a profile trace for a plurality of implant regions and comparing the generated trace to a target trace. Moreover, Kotani does not disclose or suggest the step of modifying at least one parameter of an ion implant process to be performed on subsequently processed substrates if there is a deviation between these generated trace and the target trace. Again, it is believed that a fair reading of Kotani leads to the inescapable conclusion that this limitation is not disclosed or suggested in Kotani. For at least these reasons, it is respectfully submitted that the Examiner erred in rejecting independent claim 8. Applicant respectfully requests that the Board reverse the Examiner's rejection of claim 8 and all claims dependent therefrom.

Independent claim 16 is believed to be allowable for many of the reasons set forth above with respect to claim 1, *i.e.*, independent claim 16 requires the step of comparing the generated profile trace to a calculated profile trace in a library. As indicated above with respect to claim 1, it is believed that none of the art of record cited by the Examiner discloses the step of using such a calculated profile trace for such a purpose. Applicant respectfully requests that the Board reverse the Examiner's rejection of claim 16 and all claims dependent therefrom.

Similarly, independent claim 24 is believed to be allowable for many of the reasons set forth above with respect to independent claim 8. Additionally, independent claim 24 requires that each of the calculated profile traces correspond to a unique profile of an implant region. Accordingly, it is believed that independent claim 24, and all claims depending therefrom, are in condition for immediate allowance.

Independent claim 31 is also believed to be allowable for many of the reasons set forth above with respect to claim 8.

In view of the foregoing, Applicant respectfully submits that the Examiner's assertion that the inventions defined in the pending claims are obvious in view of Kleinknecht and Kotani, or any other art of record, necessarily involved an improper use of hindsight using Applicant's disclosure as a roadmap. A recent Federal Circuit case makes it crystal clear that, in an obviousness situation, the prior art must disclose each and every element of the claimed invention, and that any motivation to combine or modify the prior art must be based upon a suggestion in the prior art. *In re Lee*, 61 U.S.P.Q.2d 143 (Fed. Cir. 2002). Conclusory statements regarding common knowledge and common sense are insufficient to support a finding of obviousness. *Id.* at 1434-35.

IX. CONCLUSION

In view of the foregoing, it is respectfully submitted that the Examiner erred in not allowing claims 1, 2 and 4-37 over the prior art of record. Applicant respectfully requests the Board reverse the Examiner's rejections. The undersigned attorney may be contacted at (713) 934-4055 with respect to any questions, comments or suggestions relating to this appeal.

Respectfully submitted,

WILLIAMS, MORGAN & AMERSON
CUSTOMER NO. 23720

Date: November 22, 2004

J. Mike Amerson
Reg. No. 35,426
10333 Richmond, Suite 1100
Houston, Texas 77042
(713) 934-4055
(713) 934-7011 (facsimile)

ATTORNEY FOR APPLICANT

APPENDIX A

1. A method, comprising:

providing a semiconducting substrate;

forming a first plurality of implant regions in said substrate;

illuminating said first plurality of implant regions with a light source in a scatterometry tool, said scatterometry tool generating a trace profile corresponding to an implant profile of said illuminated implant regions; and

creating a library comprised of a plurality of calculated trace profiles of implant regions having varying implant profiles.

2. The method of claim 1, further comprising generating an additional trace profile for an additional plurality of implant regions formed in said substrate or additional substrates, said additional plurality of implant regions having an implant profile different from said first plurality of implant regions.

4. The method of claim 1, wherein forming a first plurality of implant regions in said substrate comprises forming a first plurality of implant regions to thereby define a grating structure in said substrate.

5. The method of claim 1, wherein said first plurality of implant regions are comprised of N-type dopant material or P-type dopant material.

6. The method of claim 1, wherein said first plurality of implant regions are illuminated using at least one of a multiple wavelength light source and a single wavelength light source.

7. The method of claim 1, wherein said implant profile is comprised of at least one of a width, a depth, a dopant concentration level, and a dopant concentration profile of said implant regions.

8. A method of measuring profiles of implant regions formed in a semiconducting substrate, comprising:

forming a plurality of implant regions in a semiconducting substrate;

illuminating said plurality of implant regions;

measuring light reflected off the substrate to generate a profile trace for said implant regions;

comparing the generated profile trace to a target profile trace; and

modifying, based upon a deviation between the generated profile trace and the target profile trace, at least one parameter of an ion implant process used to form implant regions on subsequently processed substrates.

9. The method of claim 8, further comprising correlating the generated profile trace to a profile trace from a library, the profile trace from the library having an associated implant region profile.

10. The method of claim 9, further comprising modifying, based upon a deviation between the generated profile trace and a profile trace from the library, at least one parameter of an ion implant process used to form implant regions on subsequently processed substrates.

11. The method of claim 8, wherein measuring the reflected light comprises measuring the intensity of the reflected light.

12. The method of claim 8, further comprising providing a library of calculated profile traces, each of which correspond to a unique profile of an implanted region.

13. The method of claim 8, wherein measuring light reflected off the substrate to generate a profile trace for said implant regions is performed prior to the implanted regions being subjected to an anneal process or a diffusion process.

14. The method of claim 8, wherein measuring light reflected off the substrate to generate a profile trace for said implant regions is performed after the implanted regions have been subjected to an anneal process or a diffusion process.

15. The method of claim 8, wherein modifying at least one parameter of an ion implant process comprises modifying at least one of an implant energy, an implant angle, a dopant material, and a dopant material concentration.

16. A method of measuring profiles of implant regions formed in a semiconducting substrate, comprising:

forming a plurality of implant regions in a semiconducting substrate;

illuminating said plurality of implant regions;

measuring light reflected off the substrate to generate a profile trace for said implant regions;

comparing the generated profile trace to a calculated profile trace in a library, the calculated profile trace having an associated implant region profile; and

modifying, based upon said comparison of the generated profile trace and the calculated profile trace, at least one parameter of an ion implant process used to form implant regions on subsequently processed substrates.

17. The method of claim 16, further comprising comparing the generated profile trace to a target profile trace from said library.

18. The method of claim 17, further comprising modifying, based upon a comparison of the generated profile trace and the target profile trace, at least one parameter of an ion implant process used to form implant regions on subsequently processed substrates.

19. The method of claim 16, wherein measuring the reflected light comprises measuring the intensity of the reflected light.

20. The method of claim 16, further comprising providing a library of calculated profile traces in a library, each of which correspond to a unique profile of an implanted region.

21. The method of claim 16, wherein measuring light reflected off the substrate to generate a profile trace for said implant regions is performed prior to the implanted regions being subjected to an anneal process or a diffusion process.

22. The method of claim 16, wherein measuring light reflected off the substrate to generate a profile trace for said implant regions is performed after the implanted regions have been subjected to an anneal process or a diffusion process.

23. The method of claim 16, wherein modifying at least one parameter of an ion implant process comprises modifying at least one of an implant energy, an implant angle, a dopant material, and a dopant material concentration.

24. A method of measuring profiles of implant regions formed in a semiconducting substrate, comprising:

forming a plurality of implant regions in a semiconducting substrate;

illuminating said plurality of implant regions;

measuring light reflected off the substrate to generate a profile trace for said implant regions;

providing a library comprised of a plurality of calculated profile traces, each of which correspond to a unique profile of an implanted region;

comparing the generated profile trace to at least one of said calculated profile traces from said library; and

modifying, based upon said comparison of the generated profile trace and the calculated profile trace, at least one parameter of an ion implant process used to form implant regions on subsequently processed substrates.

25. The method of claim 24, further comprising comparing the generated profile trace to a target profile trace.

26. The method of claim 25, further comprising modifying, based upon a deviation between the generated profile trace and the target profile trace, at least one parameter of an ion implant process used to form implant regions on subsequently processed substrates.

27. The method of claim 24, wherein measuring the reflected light comprises measuring the intensity of the reflected light.

28. The method of claim 24, wherein measuring light reflected off the substrate to generate a profile trace for said implant regions is performed prior to the implanted regions being subjected to an anneal process or a diffusion process.

29. The method of claim 24, wherein measuring light reflected off the substrate to generate a profile trace for said implant regions is performed after the implanted regions have been subjected to an anneal process or a diffusion process.

30. The method of claim 24, wherein modifying at least one parameter of an ion implant process comprises modifying at least one of an implant energy, an implant angle, a dopant material, and a dopant material concentration.

31. A method of measuring profiles of implant regions formed in a semiconducting substrate, comprising:

forming a plurality of implant regions in a semiconducting substrate;

illuminating said plurality of implant regions;

measuring light reflected off the substrate to generate a profile trace for said implant regions;

comparing the generated profile trace to a target profile trace; and

modifying, based upon a deviation between the generated profile trace and the target profile trace, at least one parameter of an ion implant process used to form implant regions on subsequently processed substrates, said at least one parameter comprises of at least one of an implant energy, an implant angle, a dopant material, and a dopant material concentration..

32. The method of claim 31, further comprising comparing the generated profile trace to a calculated profile trace in a library, the calculated profile trace having an associated implant region profile.

33. The method of claim 32, further comprising modifying, based upon said comparison of the generated profile trace and the calculated profile trace, at least one parameter of an ion implant process used to form implant regions on subsequently processed substrates.

34. The method of claim 31, wherein measuring the reflected light comprises measuring the intensity of the reflected light.

35. The method of claim 31, further comprising providing a library of historical profile traces, each of which correspond to a unique profile of an implanted region.

36. The method of claim 31, wherein measuring light reflected off the substrate to generate a profile trace for said implant regions is performed prior to the implanted regions being subjected to an anneal process or a diffusion process.

37. The method of claim 31, wherein measuring light reflected off the substrate to generate a profile trace for said implant regions is performed after the implanted regions have been subjected to an anneal process or a diffusion process.